

Kinetic equilibrium reconstruction on TCV: towards a self-consistent approach

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The equilibrium reconstruction of TCV plasmas is usually performed making use of only external magnetic measurements. Not using internal measurements from the confined plasma, such as those provided by an MSE diagnostic, results in an ambiguous reconstruction of the current and pressure profiles, which ultimately reflects on the q profile. Moreover, the limited number of basis functions used to represent the plasma profiles when computing the equilibrium makes the latter inaccurate particularly in the presence of steep pressure gradients or a peaked current density profile.

When kinetic plasma measurements (n_e , T_e , T_i) are used in the reconstruction one refers to kinetic equilibrium reconstruction: the pressure is constrained by measurements while the current density profile is constrained by solving the time-dependent flux surface averaged Ohm's law. We tackled this problem by coupling the free-boundary equilibrium reconstruction code LIUQE [1] to the transport code ASTRA [2] solving just for the flux surface averaged Ohm's law. The coupling is performed by taking the pressure and current density profiles from ASTRA as basis functions for LIUQE but allowing them to be scaled in order to minimize the error between the equilibrium solution and magnetic measurements. This scheme was chosen with the purpose of re-using existing, well benchmarked tools as much as possible with the smallest possible number of modification so that their future individual upgrades will not affect the coupling. The scheme has proven to converge and to produce more realistic evolution of internal inductance in the presence of central and off-axis current drive.

It will also be used to study H-mode plasmas in the presence of NBI heating and the effects of strong pressure flattening due to NTMs. The tool can be run autonomously (without human interaction) and is aimed at being used routinely for experimental data analysis of TCV discharges.

[1] Pereverzev, G. V., & Yushmanov, P. N. (2002). ASTRA. Automated System for TRansport Analysis in a tokamak.

[2] Moret, J. M., Duval, B. P., Le, H. B., Coda, S., Felici, F., & Reimerdes, H. (2015). Tokamak equilibrium reconstruction code LIUQE and its real time implementation. *Fusion Engineering and Design*, 91, 1-15.